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The Scotian Shelf fisheries for Jonah crab *Cancer borealis*, and deep-sea red crab, *Geryon quinquedens*, 1984

by

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Abstract

Information is presented on the development of the directed fishery for jonah crab, Cancer borealis, on the Scotian Shelf during 1984. Before the fishery closed after gear conflict problems, 93.4 metric tons (MT) (logbooks)/148.6 MT (sales slips)) of jonah crab were landed by three permit holders through May-August. Port sampling of commercial catches indicates that the mean size for landed males remained similar to 1983 values and well above the minimum size limit of 130 mm carapace width (CW). Female crabs were, on average, smaller than the males and comprised only 6% by numbers, of landings sampled. Catch and effort statistics compiled from fishermen's logbook show that the mean catch rate pattern tended to fluctuate considerably but generally remained above 1983 values through the 1984 season.

Difficulties with the jonah crab fishery led to a re-targeting onto deep-sea red crab, Geryon quinquedens, on the Scotian Shelf edge. Background information is presented on the development of the red crab fishery. Currently, two vessels are focussing exclusively on red crab with a possibility of further vessels eventually entering the fishery. Logbook records from three vessels over July-December detail 7887 trap hauls for a catch of 132.0 MT (110.9 MT indicated from sales slips) and a mean CPUE of 16.7 kg·trap haul^{-1}. The mean catch rate per trip pattern fluctuated over the fishing season (range: 3.6-24.6 kg·trap haul^{-1}) although the general trend appeared stable. A port sample of male red crabs landed in December displayed a CW range of 105-147 mm with a mean at 126.5 mm; 87% (N = 90) of the sample were at or above the minimum CW of 115 mm. Nine (9%) of the red crab had an intermediate shell hardness, the remainder were hard-shelled. No females were found among the ~1,000 red crab examined.

Résumé

On présente de l'information sur l'évolution de la pêche dirigée au crabe-tourteau boréal, Cancer borealis, sur le plateau Scotian en 1984. Avant la fermeture de pêche survenue après des problèmes liés à un conflit avec les engins de pêche, trois detenteurs de permis avaient, entre mai et août, débarqué 93,4 tonnes métriques (journaux de bord)/148,6 tonnes métriques (bordereaux d'achat) de crabe-tourteau boréal. L'échantillonnage au port des prises commerciales indique que la taille moyenne des mâles capturés était semblable à celle de 1983 et bien supérieure à la taille minimale exigée (largeur de la carapace de 130 mm). Les femelles étaient en moyenne plus petites que les mâles et ne constituaient, dans les débarquements échantillonnées, que 6 % des crabes capturés. Les données statistiques concernant les prises et l'effort de pêche et compilées à partir des journaux de bord des pêcheurs montrent que le taux de capture moyen a varié considérablement, mais qu'en général, il s'est maintenu au cours de la saison 1984 au-dessus de la valeur de 1983.

Les difficultés qui ont touché la pêche au crabe-tourteau boréal ont amené les pêcheurs à se tourner vers le crabe rouge, Geryon quinquedens, en bordure du plateau Scotian. On présente des données de base sur l'évolution de la pêche au crabe rouge. A l'heure actuelle, deux navires se consacrent exclusivement à la pêche au crabe rouge et d'autres navires pourraient éventuellement se joindre à eux. Les journaux de bord de trois navires indiquent qu'au cours de la période de juillet à décembre, on a remonté 7 887 casiers pour une prise de 132,0 tonnes métriques (110,9 tonnes métriques selon les bordereaux d'achat) et une PUE moyenne de 16,7 kg par casier remonté$^{-1}$. Le taux de capture moyen par sortie à varié au cours de la saison de pêche (variation : 3,6 à 24,6 kg par casier remonté$^{-1}$), bien que la tendance générale ait semblé stable. Un échantillonnage réalisé au port des crabes rouges mâles débarqués en décembre a indiqué que la variation de la largeur de la carapace était de 105 à 147 mm, pour une moyenne de 126,5 mm; 87 % des crabes échantillonnées (N = 90) présentaient une largeur de carapace égale ou supérieure à la valeur minimale de 115 mm. Chez 9 % des crabes rouges, la carapace avait une dureté intermédiaire; la carapace était dure chez les autres. Aucune femelle n'a été décelée parmi les quelque 1 000 crabes rouges examinés.

Introduction

The purpose of this paper is to document and review fishing operations for jonah crab and red crab in 1984. In addition, pertinent biological information is provided to a planned review of the Scotian Shelf crab fisheries in 1985 and consideration of further regulations.

Jonah Crab

The jonah crab, Cancer borealis (Fig. 1), commonly occurs between Nova Scotia and the Bermudas, from the intertidal zone to a depth of approximately 800 m (Rathbun 1929; Squires 1966). Since at least the mid-1960's, the jonah crab resource in Canadian waters has been subject to sporadic low-level exploitation as a by-catch to the trap fishery for American lobster, Homarus americanus (Caddy et al. 1974). The principal barriers to further development of a commercial jonah crab fishery appear to have been the poor economic returns on the marketed product (due mainly to high costs of meat extraction) and enforcement difficulties (jonah crab and lobster overlap in distribution and, therefore, the higher-value lobsters are liable to damage and poaching). With the collapse of Alaskan crab stocks in 1982 and the subsequent increase in world market demand and price for crab, the economics of directed fisheries on underutilized crabs became more viable. Consequently, in 1983 a jonah crab fishery was initiated on the Scotian Shelf. Thirty-two permits were drawn for of which 10 became active. In order to encourage participation, a minimum number of regulations were instigated. Those that related to the biology of the resource are as follows:

- the area of direct fishing is restricted to 12 or more miles off the coast; north and east of a line which commences 12 miles off at 65°63' west longitude, proceeds true south to 43° north latitude, then true east to 64°30' west longitude, then true south to the "200-mile" limit (Fig. 2) (to exclude existing lobster fisheries);

- a minimum size limit of 130 mm carapace width (CW) must be adhered to;

- crabs must be landed in live, whole condition;

- subject to ongoing review, no restrictions were imposed during 1983 (or 1984) regarding quotas, gear, sex (including berried females) or season;

- log records as supplied by Fisheries Research Branch must be faithfully kept and observers carried upon request;

- any crab caught as a bycatch in an otherwise directed fishery may be landed and sold, subject to the minimum size limit of 130 mm;

- the directed fishery must be conducted through the issuance of exploratory permits for 1983 (and 1984).

In the matter of permit applications, it was recommended:

- that eligibility be limited to those in possession of a registered fishing vessel of 35 or more feet in length carrying at least one limited fishing license. (Note: the size restriction was seen to be prudent in the interests of safety, especially in view of the "12-mile offshore" restriction.)

The 1983 season was assessed by Elner and Robichaud (1984). The landings, as derived from logbooks, totalled 90.3 MT after a season of 4 mo. Fishing stopped in August 1983 when the principal buyer ceased operations. Traps were set in the LaHave/Emerald Basins and on the Scotian Shelf edge. Catch rates fluctuated considerably, with a slight upward trend, and a mean value of 6.6 kg·trap haul^{-1}. The fluctuations in the catch rates appeared due, to some degree, to the exploratory nature of the fishery. The preferred gear was offshore lobster traps with soak times ranging from 1 to 14 d. From port sampling of landings, males comprised 96% of the catch and ranged in size from 114 to 182 mm CW. Females ranged from 110 mm to 142 mm CW; only 1.2% of the total catch were females above the 130 mm CW size limit. Size frequency distributions of landed crabs did not change appreciably during the season. No soft-shelled crabs or ovigerous females were observed during sampling.

In 1984 the jonah crab fishery on the Scotian Shelf reported reasonable success overall but failed to regain impetus following heavy gear losses in late June. The Scotian Shelf fishery for jonah crab effectively ceased in late August and was replaced by a deeper water fishery for red crab, a species which had previously been a by-catch to jonah crab.

Red Crab

The deep-sea red crab, Geryon quinquedens (Fig. 3), is widely distributed in the Atlantic, Pacific and Indian Oceans at depths from 40 to 2155 m. In the western Atlantic, red crabs are found from Nova Scotia to Argentina and are most common from 265-915 m (Rathbun 1929; Scelzo and Valentini 1974); they occur on mud, sand or hard bottoms where temperatures are between ~4-12°C. Males attain a maximum carapace width of 178 mm and weight of 1.35 kg; females reach 140 mm CW. Sexual maturity in females is at 80-91 mm CW while males are reported to be "physiologically mature at a relatively small size" (Haefner 1977). No discrete molting period has been discerned, and a slow growth rate is inferred from tag returns. Red crabs are estimated, from laboratory studies, to grow to fishable size in 5-6 yr at 15-9°C (Van Heukelem et al. 1983). As they grow older and larger, the crabs migrate up the continental slope; superimposed on this, there is a possibility of seasonal migrations up and down the slope (Wigley et al. 1975). Mark-recapture studies have indicated little movement by adults along the continental slope (Gerrior 1981). However, given larval vertical migration behavior and development times in excess of 80 d, red crab larvae

have the potential to be dispersed for considerable distances in the NE flow of the Gulf stream (Kelly et al. 1982). Kelly et al. (1982) has hypothesized that red crab in the mid-Atlantic Bight form a single "genetic" stock.

The U.S. red crab landings began in 1973 as by-catch to the offshore lobster fishery. Currently, two large (>100' steel) red crab vessels operate out of southern New England. Most trapping is along the continental slope between Lydonia Canyon and Toms Canyon with only minor effort to the eastwards (Gerrior 1981). Reported total landings were approximately 1,200 MT per annum in the late 1970's and annual landings for the past 2 yr have been ~3000 MT (Table 1). Although there has been limited fishing in Corsair Canyon, major commercial activity has been well south of the new U.S.:Canada boundary on Georges Bank. A comprehensive survey in 1974 (Wigley et al. 1975) estimated a commercial red crab biomass (>114 mm, CW) biomass of 27,000 t in continental slope waters from Maryland to Corsair Canyon. Greatest biomass concentrations were apparent off southern New England, with relatively few red crab being located off Georges Bank. No red crab were caught at the two trawling stations on the Canadian side of the new boundary.

Exploitation of red crab in Canadian waters started in the late 1960's and was sporadic until the mid-1970's when fishing ceased due to unfavorable economics (Table 1). However, red crab landings began again in the latter half of 1984 as by-catch to the pilot fishery for jonah crab. Subsequently, one vessel (wooden 97') directed exclusively onto red crab and landings had reportedly surpassed 100 MT by early November, with catches of 10-15 MT per trip. One further vessel (steel 116' ex-herring seiner with RSW) commenced operations in December and there appear possibilities for an additional two large steel vessels (ca. 120' to enter the fishery in 1985). Gear used are an unrestricted number of modified offshore lobster traps, set in strings of approximately 80 traps at ~400-800 m on the continental slope.

Management goals, strategy and regulations for the fledgling Canadian red crab fishery have yet to be ratified. The preemptive TAC of 1,300 MT is based on a 50% exploitation rate (as recommended by CAFSAC for snow crab, Chionoecetes opilio) of the commercial biomass, conservatively, assessed along the Scotian Shelf edge from the Fundian Channel, south of Browns Bank, to the Gully, east of Sable Island, by DFO trapping surveys in 1980 and 1981 (McElman and Elner 1982, unpublished data). A previous red crab survey in 1978 (Stone and Bailey 1980) was conducted along the Shelf edge between Sable Island Bank and NE Georges Bank. In all three surveys, red crab appeared patchily distributed with maximum abundances occurring between LaHave and Emerald Banks at 180-900 m (Stone and Bailey 1980; McElman and Elner 1982, unpublished data). There is an agreed minimum size of 115 mm CW for Canadian red crab, close to the 114 mm CW minimum accepted by the U.S. fishery (Haefner 1978). There are no season restrictions at present.

While the commercial biomass of red crab may prove to be greater than the 2,600 MT originally estimated, productivity, given Canadian red crab appear at the northern limit to the distribution of the species, may be sporadic. Hence, recognizing that sustainable-yield principles may not be applicable to red crab, management has acted to limit new entrants and discourage new capital investment other than for modifications essential to exploiting this new resource. With the ratification of the new U.S.:Canada

boundary on Georges Bank, it is likely that exploratory fishing for red crab will extend westwards of the Scotian Shelf crab boundaries (Fig. 2) to Corsair Canyon.

Methods

Logbooks were supplied to all crab permit holders together with instructions on correct usage. The logbooks are as previously used in the trap fisheries for snow crab around Cape Breton Island and are designed to provide detailed catch and effort data for short-duration fishing trips. Data from sales slips provided supplementary landings statistics.

Port sampling was carried out at the major crab processing plant in Port Hebert, Nova Scotia, on an opportunistic basis throughout the fishing season to assess the size-frequency distribution and sex ratio of the commercial landings. Size for both red crab (Fig. 3) and jonah crab, was determined by measuring the carapace width (CW) across the widest part of the carapace, from tip-to-tip of the most distal marginal teeth. Chela height (h) and carapace length (CL) dimensions were also recorded for red crab (Fig. 3) for future investigations into allometric growth and size at maturity.

The 1984 fisheries for jonah crab and red crab are assessed on the basis of the logbooks, sales slips and port sampling information.

Results and Discussion

Jonah Crab

Commercial catch sampling

Carapace width-frequency distributions for male and female jonah crabs caught commercially in May to July 1984 are shown in Fig. 4. All recorded jonah crab landings originated from the Scotian Shelf edge. Mean carapace width (145.5 mm) for male jonah crab sampled in June 1984 was close to that for the same area in August 1983 (148.8 mm) and for other 1983 fishing locations on the Scotian Shelf. A limited sea sample in July 1984 shows a wider range of smaller males and a concomitant decrease in mean size to 136.5 mm CW. All carapace width-frequency distributions for the males were unimodal with a combined range from 109-175 mm CW; 95% (N = 1459) of the 1536 males sampled were at or above the 130.0 mm CW size limit.

Overall, female jonah crabs comprised only 2.1% (N = 31) of the total number of jonah crabs sampled (N = 1500) in port. However, of the 138 jonah crabs measured at-sea, 71 (51%) were female producing a male:female sex ratio of 1.0:1.1. As noted in 1983 (Elner and Robichaud 1984), the mean carapace widths (130.3 mm, 113.4 mm) and size ranges (116.0-143.0 mm, 96.0-132.0 mm CW) for females sampled in 1984 were considerably less than those for males and only 18% (N = 18) of the females were at or above the 130.0 mm CW size limit.

A sample of 500 jonah crabs landed at Port Hebert on June 18 were all in a hard-shelled condition.

Logbooks

Logbooks were received from three permit holders who participated in the 1984 fishery for jonah crab. The various locations at which jonah crabs were trapped, as identified from the logbooks, are shown in Fig. 5. Fishing grounds in Emerald Basin and LaHave Basin that were exploited in 1983 (Elner and Robichaud 1984) appear to have been ignored in 1984 in favor of heavier but more distant crab concentrations on the Scotian Shelf edge. Fishing depths ranged from 106-641 m, with a mean of 375 m. Trap soak times averaged 6 d (range: 2-15 d). In total, the logbooks show 1220 traps in the fleet (range: 270-350 traps/vessel) and record 7008 trap hauls over the 1984 season.

Landings and effort statistics from logbook data are presented for each vessel in Table 2.

At an approximate price to the fishermen of $0.33/lb ($0.73/kg), the landings of 98.4 MT (148.6 MT from sales slips) have an estimated value of $68,215 ($108,496 from sales slips). Weekly catch and effort statistics for the fleet are given in Table 3 and Fig. 6, along with comparative values for 1983. Although mean CPUE for the fleet fluctuated markedly through the season, the general pattern is similar to that observed in 1983 but with higher catch rates.

Red Crab

Commercial catch sampling

A carapace width-frequency distribution for male red crabs landed in December 1984 on the maiden trip of the 116' steel vessel is shown in Fig. 7. The red crab were trapped between ~366-641 m on the Scotian Shelf edge off Emerald Bank. Mean carapace width (126.5 mm) was close to that determined for the 366-548 m depth zone (125.6 mm) along the Scotian Shelf edge by McElman and Elner (1982). The CW-frequency distribution is unimodal with a CW range of 105-147 mm; 87% (N = 90) of the sample (N = 103) was above 115 mm CW. Nine (9%) of the 103 crabs sampled had an intermediate shell-hardness, the remainder were hard-shelled; the Port Hebert processing plant and logbooks have reported persistent but relatively small numbers of soft- to intermediate-shelled red crabs in landings to-date[1].

No female red crabs were found in the catch examined (N = ~1,000) and they have apparently been uncommon in all landings at the Port Hebert plant. Gerrior (1981), in a review of studies on the distribution of red crab, demonstrated that females appear most abundant at shallower depths (320-503 m) while males have a more uniform distribution over a wide depth range (320-1280 m). Similarly, size appears inversely related to depth with mean size of both male and female crabs decreasing with increasing depth. These

[1]Red crab fishing has produced a by-catch of jonah crab, but no discernible lobster by-catch to-date.
(Note: Many of the red crabs sampled had goose-barnacles on their carapace)

distribution patterns have been confirmed by surveys in Canadian waters (Stone and Bailey 1980; McElman and Elner 1982) and suggest that the general absence of females from landings is a result of sexual differences in distribution with depth.

Logbooks

Logbook records, detailing 22 fishing trips, were received from three vessels targetting onto red crab over the period July 17-December 15, 1984. Locations over which trap strings were set are shown in Fig. 5. Most favorable catches were on firm clay/mud bottoms. Fishing depths ranged from 457-640 m, with a mean of 549 m. Traps were soaked over a 2-11 d period (mean: 6 d). In total, logbook records show a total of 7887 trap hauls for a catch of 132,045 kg (110,913 kg from sales slips) and a mean CPUE of 16.7 kg·trap haul^{-1} (Table 4). At a price of $0.40/lb ($0.88/kg) the landings have an estimated value of $116,200 ($97,603 from sales slips). The CPUE pattern over the fishing season is shown in Fig. 8. Fluctuations in mean CPUE values probably reflect the searching and exploratory mode of the developing fishery although the general tend appears stable.

Discussion

The directed jonah crab and red crab fisheries on the Scotian Shelf are both essentially exploratory fisheries on virgin resources. Fishermen are searching out and exploring new fishing grounds and, at the same time, experimenting with various trap types and fishing strategies on unfamiliar target species. For the 1984 season, relative abundance patterns (in terms of CPUE) for jonah crab and red crab were erratic but showed no discernible overall trend while mean sizes for landed crabs remained high. Both these latter factors suggest that the 1984 fishery did little to impact either resource. In the shorter term, given that fishing effort is maintained, catch rates and landings for both crab species can be expected to increase as fishermen become more adept at exploiting the resources. The increases in mean CPUE values for jonah crab in 1984, compared to 1983, appear to well illustrate the propensity for fishermen to increase their fishing power with experience. Over a longer term, the accumulated virgin biomasses will become depleted and the fisheries will rely increasingly on annual recruitment and growth over the size limits. However, as there is no information on the available biomass of jonah crab or the production characteristics of either jonah crab or red crab, meaningful longer-term prognoses for the fisheries are impossible. It should be noted however that while the USA is attempting to rationalize exploitation of their red crab resource on the basis of MSY (annual sustained yield for the area between Goerges Bank and offshore Maryland has been estimated at 2,700 MT, 10% of the assessed commercial biomass (Anon. 1984)), the Canadian fishery is being initially developed around a target exploitation rate of 50%.

For both the jonah crab and red crab fisheries, minimum sizes are all above postulated sizes of maturity. Thus, males should be able to mate and females express eggs before becoming vulnerable to exploitation. Given also that females are relatively smaller than the males and form only a small proportion of the landings, they will be subject to less fishing pressure than males and the reproductive potential of the resources should be further protected.

Presently, the Scotian Shelf crab venture appears to be assuming a distinctly bipartite aspect:

- a seasonal midwater fishery on the Scotian Shelf and Shelf edge directed at jonah crab and pursued by vessels capable of operating, under favorable weather conditions, beyond 20 miles from shore.

- a deepwater fishery on the Shelf edge with year-round potential directed primarily at red crab. Logistic requirements call for relatively large vessels (~100' class) with provision for holding the catch live for several days. Ice has proven less than satisfactory, and the new steel vessel entering the fishery is using a RSW* system with success (the U.S. fishery for red crab employs butchering and freezing at sea, an option not available to Canadian industry under current policy).

While the red crab fishery appears to have more than sufficient effort potential (two large vessels presently active and a further two large vessels a possibility) to harvest the provisional TAC of 1,300 MT, development of the jonah crab fishery has been handicapped by landing shortages. More fishing effort is urgently required for the 1985 jonah crab season, it has been estimated that the catch from at least ten active vessels could be readily accommodated.

Prudence dictates a cautious approach towards allowing additional vessels into the Scotian Shelf crab fisheries; however, industry enterprise should not be unduly restricted as it is only from the "flux" imparted by an active fishery that data on surplus production dynamics needed to optimize exploitation will be generated. In addition, although the reproductive integrity of the jonah crab and red crab resources appears well buffered against overharvesting, there remains much basic biological knowledge (e.g. size of male maturity for red crab) that is both lacking and essential to future management -- a supply of crabs from the fisheries will provide the raw material to address these fundamental questions.

*Refrigerated sea water

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Table 1. Commercial biomass estimates (MT) and landings (MT) for deep-sea red crab, Geryon quinquedens, in the N.E. Atlantic (by NAFO areas).

		1971-1975 average	1976	1977	1978	1979	1980	1981	1982	1983	1984
Biomass	Canada							2,600[a]			
	USA	26,700[b]									
Canada landings	4W 4X 5ZE			- estimated majority of landings from 4W and majority of remainder from 4X							
	Total	26[c]	<1	0	0	0	0	0	0	0	111[d]
N.E. USA (MA, RI) landings	5ZE 5ZW 6A			- estimated majority of landings from 5ZEo, 5ZWq and 6A							
	Total	358	700	1,246	1,227	1,213	3,000[e]	3,000[e]	2,246	3,253	3,000[e]
Total landings (Canada + N.E. USA (MA, RI))		384	701	1,246	1,227	1,213	3,000[e]	3,000[e]	2,246	3,253	3,100[e]

[a]Survey Fundian Channel (4X) to Sable Island (4W), estimated majority in 4W.
[b]Survey Maryland (6B) to Corsair Canyon (5ZE), 46% of total off S. New England, 31% off Georges Bank.
[c]Official DFO statistics (1970: <0.5; 1971: 128; 1972: 0.5, 1973: 0.5; 1974: <1.0; 1975: 0).
[d]From sales slips statistics; logbooks indicate 132 MT.
[e]Estimated, official data unavailable.

Table 2. Catch and effort statistics from logbooks and sales slips for permit holders in the directed fishery for jonah crab, 1984. SL = Scotian Shelf edge; U = unknown.

Boat number	No. of trips	No. of traps hauled	Landings (kg) from sales slips	Landings (kg) from logbooks	Mean CPUE (kg/trap haul) over the season	Fishing grounds
1) 17	U	U	49985	U	U	U
2) 22	16	2735	26361	32125	11.8	SL
3) 24	U	U	4197	U	U	SL
4) 26	7	1573	23415	21526	13.7	SL
5) 31	12	2700	43742	39794	14.7	SL
6) 30	U	U	925	U	U	SL
Total		7008	148625	93445	13.3	SL

Table 3. Catch and effort statistics from logbook data for the directed jonah crab fishery in 1983 and 1984 off the Scotian Shelf edge.

	Scotian Shelf edge 1983				Scotian Shelf edge 1984			
Date	No. trap hauls	Catch (kg)	CPUE (kg/trap haul)	∑C (kg)	No. trap hauls	Catch (kg)	CPUE (kg/trap haul)	∑C (kg)
01/05	-	-	-	-	200	951	4.8	0
08/05	-	-	-	-	-	-	-	951
15/05	-	-	-	-	250	1844	7.4	951
22/05	-	-	-	-	470	9000	19.2	2795
29/05	-	-	-	-	1040	21429	20.6	11795
05/06	120	245	2.0	0	1090	16769	15.4	33224
12/06	520	2409	4.6	245	975	10111	10.4	49993
19/06	60	907	15.1	2654	870	11404	13.1	60104
26/06	340	1361	4.0	3561	813	9892	12.2	71508
03/07	-	-	-	-	300	2166	7.2	81400
10/07	-	-	-	-	415	4630	11.2	83566
17/07	-	-	-	-	200	2308	11.5	88196
24/07	-	-	-	-	260	2336	9.0	90504
31/07	645	5328	8.3	4922	125	605	4.8	92840
07/08	940	8503	9.1	10250	-	-	-	93445
Total	2625	18753	7.1	18753	7008	93445	13.3	93445

Table 4. Catch and effort statistics from logbook data for the red crab fishery on the Scotian Shelf edge in 1984.

Date by week periods	No. trap hauls	Catch (kg)	CPUE (kg/trap haul)
17/07	280	1014	3.6
24/07	588	4796	8.2
31/07	-	-	-
07/08	-	-	-
14/08	-	-	-
21/08	870	8346	9.6
28/08	323	4989	15.4
04/09	520	8249	15.9
11/09	497	8980	18.1
18/09	441	9892	22.4
25/09	427	7316	17.1
02/10	92	1916	20.8
09/10	392	8617	22.0
16/10	375	9070	24.2
23/10	901	18764	20.8
30/10	-	-	-
06/11	397	9784	24.6
13/11	-	-	-
20/11	-	-	-
27/11	400	4535	11.3
04/12	400	6803	17.1
11/12	584	10295	17.6
18/12	400	8679	21.7
Total	7887	132045	16.7

Fig. 1. The jonah crab, Cancer borealis.

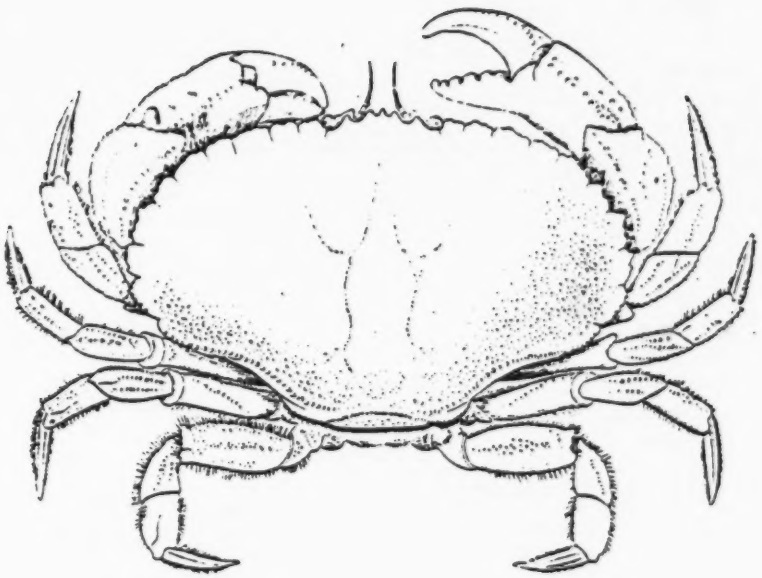

Fig. 2. The area defined for the directed jonah crab fishery in 1983 and 1984; fishing was restricted to at least 12 miles off the coast and then north and east of the boundary line (—.—.—.—.) up to the 200-mile limit (— — — — —).

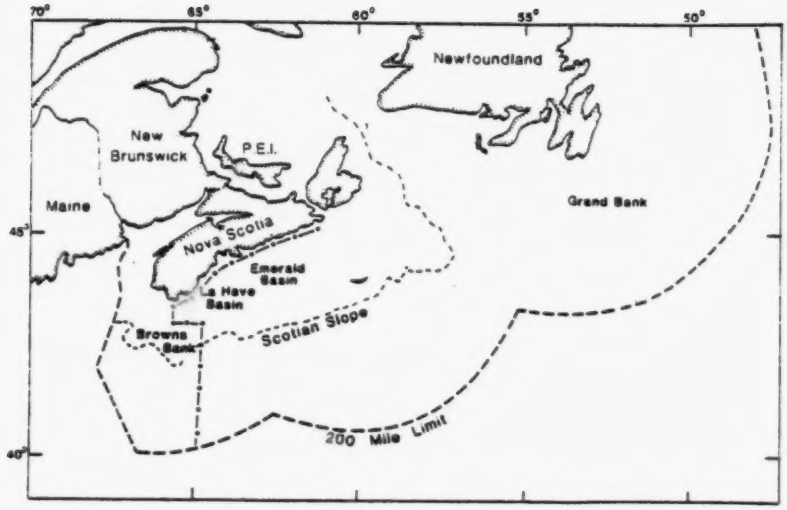

Fig. 3. The deep-sea red crab, Geryon quinquedens.

(Note: inset shows morphometric measurements taken in port sampling).

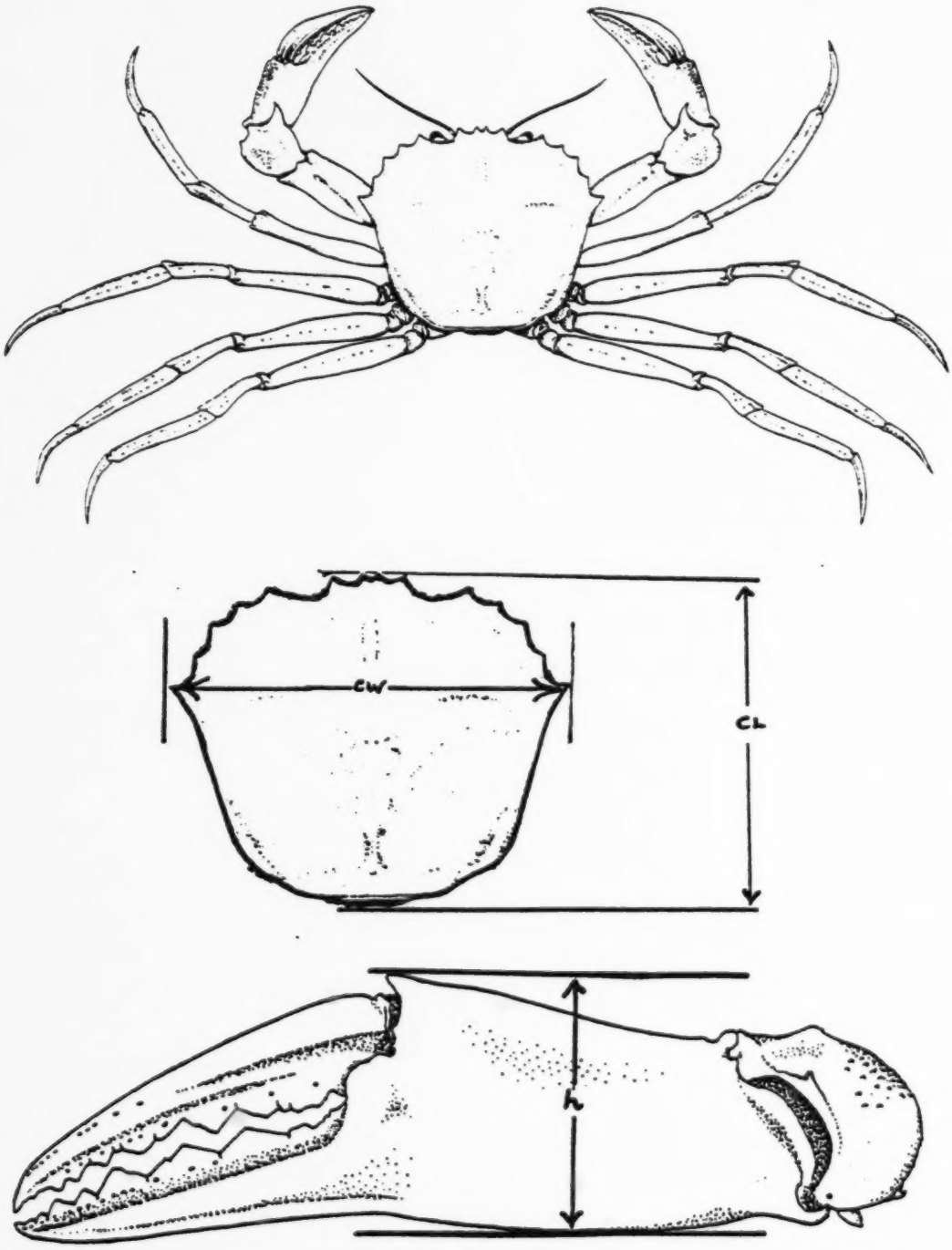

Fig. 4. Carapace width-frequency distributions for male and female jonah crabs from port and at-sea sampling during the 1984 fishing season.

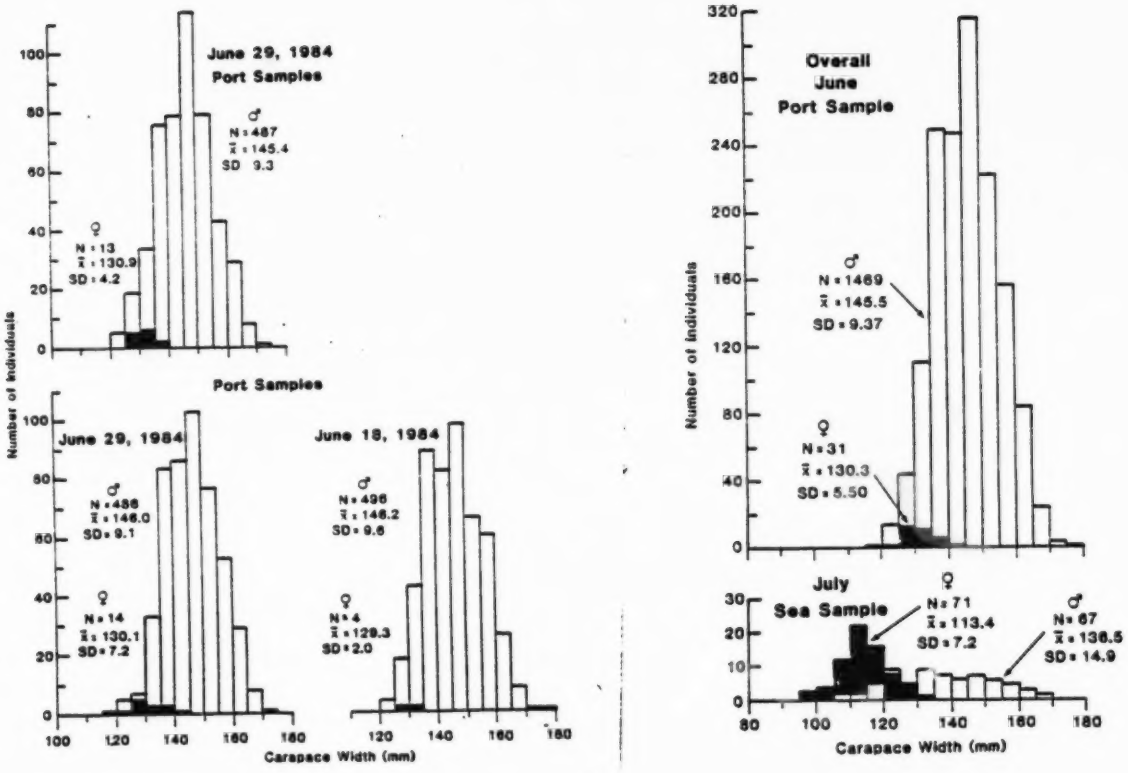

Fig. 5. Known trap locations in the directed fisheries for jonah and red crab in 1984; as determined from fishermen's logbooks.

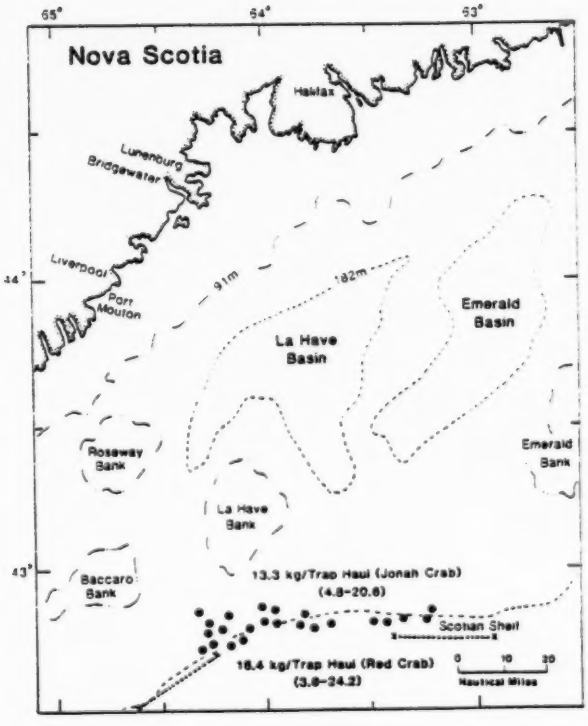

Fig. 6. Mean CPUE (kg·trap haul^{-1}) by weekly period for the directed jonah crab fishery in 1984; the comparative CPUE pattern is shown for jonah crab catches on the Scotian Shelf edge in 1983.

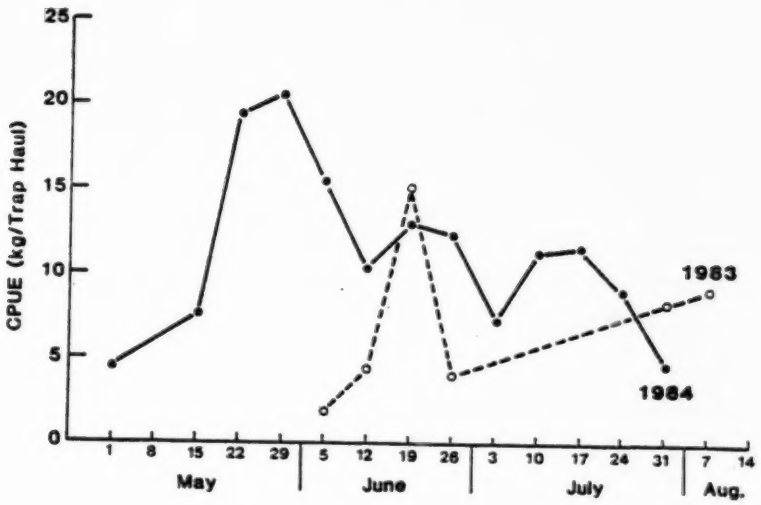

Fig. 7. Carapace width-frequency distribution for male red crab from port sampling in Decemeber 1984.

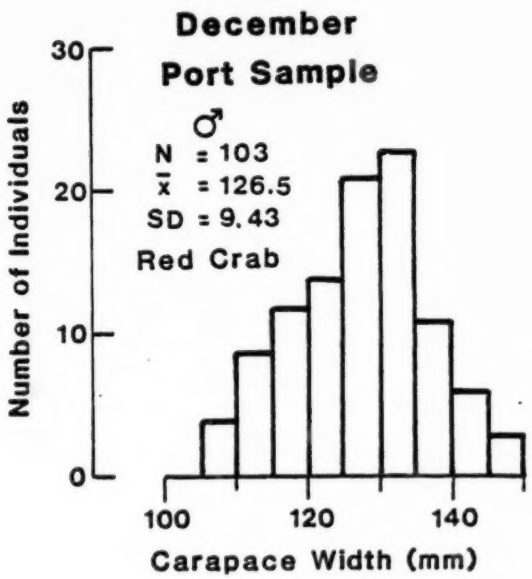

Fig. 8. Mean CPUE (kg·trap haul^{-1}) by weekly period for the directed red crab fishery in 1984.